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Developing undergraduate student oral science communication through video reflection

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ABSTRACT

This study examines an undergraduate biology instructor's use of video reflection for promoting students' development as oral science communicators. After being provided with instruction on how to communicate effectively, students were asked to give scientific oral presentations and reflectively assess their own communicative performance by critically watching video-recordings of themselves. For a considerable portion of students (40.74%), the act of watching a video of themselves led to a change in their self-perceptions. There were slightly more instances of positive change than negative ones (22.22% and 18.52%, respectively). The most self-critical students developed perceptions of themselves that were less negative than before, whereas many students who initially felt badly about their presentations developed more positive self-perceptions after watching the video. In both cases, video reflection led to a more balanced perception of how effectively students presented their selves while giving a scientific oral presentation. It is argued that video reflection can help undergraduate students develop improved self-monitoring and self-regulation during performance of oral scientific presentations, and hence prepare the next generation of scientists to have a more productive professional life.

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Science communication has been increasingly recognized as a critical aspect of scientific training. Scientists with effective communication skills can help make science more accessible to the general public and improve the populace's scientific literacy. It is also important for science to be communicated to politicians and policy makers in ways that can effectively inform their decision-making process (Brownell et al., 2013; Chan, 2011; Feliú-Mójer, 2015). Likewise, in academic tasks, the more clearly that thoughts can be expressed, the more value they may hold (Radford, 2011). For instance, to obtain funding for their research, scientists must clearly communicate to peers and reviewers how their ideas and discoveries are valuable and applicable to society (Feliú-Mójer, 2015; McNutt, 2013). Therefore, incorporating science communication education into undergraduate classrooms has become paramount.

However, opportunities for science communication skill development have generally been limited in the undergraduate science curriculum (Bankston & McDowell, 2018; Brownell et al., 2013). Scientists have been shown to be the least commonly trained professional group with respect to public communication (Besley & Tanner, 2011). Compounding the problem, some scientists feel that attempting to communicatively engage the public is not worth the effort (Chappell & Hartz,

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1998), thus limiting the time devoted to public outreach (Andrews et al., 2005). As such, educating undergraduate science students about communication and improving their ability to communicatively perform is essential to help ensure that the next generation of scientists will have a more productive professional life.

In an effort to address the above issue, this study examines the potential of video-based self-reflection as a tool for promoting oral science communication development in the context of an undergraduate biology class in which students were provided with science communication instruction on how to communicate effectively. Students were then asked to reflectively assess their own communicative performance by critically watching video-recordings of themselves giving oral scientific presentations. Our specific research question is: How does video-based self-reflection affect undergraduate biology students' development as oral science communicators?

Literature review

The scholarly work informing our study includes the literatures on oral science communication and video-based approaches to professional preparation.

Oral science communication

Central to the scientific profession, science communication can be loosely defined as any activity that involves one person orally sharing science-related information with another, with more specific definitions arising when distinguishing between the target audience of such communications. For example, *scientific communication* is the highly specialized form of language used among specialists, such as during scientific presentations in academic events (e.g. science conferences) or publications in scientific journals (Kobylarek, 2017), whereas the more accessible form of *popular science communication* is employed during talks in public outlets (e.g. interviews with media) and public outreach (e.g. guest lectures; Feliú-Mójer, 2015; Kuehne et al., 2014). As such, science can be shared with varied audiences, including other scientists/people with scientific expertize, policy makers, and laypeople/non-scientists who have little (if any) background knowledge on the subject. These oral communicative activities can be supported by diverse set of tools such as PowerPoint slideshows and electronic media (e.g. videos, animations, etc.).

Becoming an effective oral communicator of science is far from simple. In addition to extensive scientific knowledge about the topic at hand, giving effective science presentations also require expertize in oral performance. Once on the academic stage, the student-presenter has to be able to convincingly perform a series of discursive acts consistent to different degrees with a projected science expert self-image (i.e. to exhibit competence in enacting a scientific self). Presenting oneself scientifically can also be conceived as a task of *impression management* (Goffman, 1959), that is, the speaker attempts to influence (manage) an audience's perceptions about oneself by strategically presenting him/herself in a manner that is consistent with the role of scientist.

Recent research on oral presentations in academic settings has revealed a wide variety of strategies commonly used by effective oral communicators. For instance, effective oral communicators have been known for favoring an extemporaneous form delivery. Rather than reading the text verbatim with both eyes fixed on the PowerPoint slide, effective speakers tend read the text extemporaneously (making eye contact with the audience and using gestures such as leaning forward and taking off glasses; Tannen, 1988). Extemporaneous speakers also use *engagement strategies* such as parenthetical remarks, jokes, stories, elaborations and asides to create the illusion of fresh talk (i.e. an impression that the text is being formulated at the moment of delivery) and to foster closeness, intimacy and camaraderie with the audience (Tracy, 1997). Strategies examined by more recent research include speaking rate, timing, social skill (handing difficult questions from the audience), and rhetorical style (Hincks, 2010). Also examined are retrieval strategies used to call up language and recollect information (e.g. memorizing the text, using notes), and rehearsal strategies such as practicing before presenting (Chou, 2011). In addition to revealing what can be considered to be helpful 'tricks of trade' for novice academic communicators, this literature also underscores the highly dynamic and context-dependent nature of oral academic performance.

When it comes to the development of professional oral communication, one potentially fruitful way of improving communicative performance is through video analysis of one's own presentation. Video reflection on communicative performance has been used with great success in other professional fields (e.g. Penny & Coe, 2004; Zick et al., 2007), suggesting that it could also constitute a tool of pedagogical value in scientists' preparation. However, research on video reflection in the specific context of science communication education is notably absent from the existing literature. There is a need for the study and careful consideration of video as a tool to enable, bolster, and facilitate students' professional development as oral science communicators at the undergraduate level.

Video watching in professional training

The use of video as a tool for reflection is prevalent in professional fields where communication acts an integral part of the profession: teachers speak to their students and medical professionals talk to their patients. Therefore, it stands to reason that carefully analyzing how oneself performs on video may also help undergraduate science students improve their science communication skills.

The potential of video to serve as a tool for improving professional communicative performance is well documented in the literature on the professional training of teachers. It has been shown that video reflection can be an effective feedback strategy for helping instructors improve their teaching performance (Penny & Coe, 2004). The use of video as a reflective device shifts teachers' attention from vague perceptions to a more complex, evidence-based analysis of their own teaching (Ball & Cohen, 1999). As teachers view and analyze videos of themselves, they notice aspects of their communication they were previously unaware of (Rosaen et al., 2008). Pre-service teachers learn to notice these aspects when they use video as a tool: they learn to pay attention to what is important, making connections between specific and broader concepts (Van Es & Sherin, 2002). The explicit noticing they experience is critical for change; without it they cannot choose to act any differently (Borko, 2004; Sherin & van Es, 2002). Watching a lesson can also bring the specific scripts, or implicit schema that instructors hold in mind with regard to education to the surface (Stigler & Hiebert, 1999). Jacobs and Morita (2002) propose that a comparison of scripts, activated by video, with teachers' personal criteria for good instruction can allow teachers to produce judgements on their own lessons.

Highlighted in the literature is the discomfort that video reflection may elicit. Such discomfort indicates that novices commonly experience some degree of social anxiety due to concerns with public image and social evaluation. Social anxiety has been shown to arise in social situations in which people set out to make a favorable impression on others but are uncertain about their ability to do so (Alden & Regambal, 2010; Leary et al., 2015). Moreover, social anxiety is commonly linked to negative self-perception and feelings of insecurity (Rapee & Hayman, 1996). Watching one's own social performance on video can amplify these feelings by forcing novices to face the extent to which their efforts may have fallen short of conveying the desired impression, and hence be met with disapproval (i.e. staring directly at 'how badly they failed' a communicative task). Nonetheless, many have argued that teachers can learn from these uncomfortable experiences (Kennedy, 2005). As Paley (1986) asserts, 'real change comes about only through the painful recognition of one's own vulnerability.' The discomfort that videos offer novice educators can in fact provide impetus for professional growth and development and become a powerful motivator for improving one's communicative performance. As such, watching videos can positively influence novices' self-perception. Better understanding how video-based self-reflection can shape science novices' self-perceptions is a central goal of this study.

Other studies of video as a tool for reflection and professional learning have focused on members of the medical community. Doctors and nurses in training have been subject to this specific kind of study, for which video analysis has been used to aid individuals training to be professional practitioners with patient relations and the development of an empathetic 'bedside manner' (Zick et al., 2007). Studies of video as a tool to aid undergraduate nursing students with communication skills are numerous (e.g. Bussard, 2016; Maclean et al., 2019; Yoo et al., 2009).

One important benefit of video-based self-reflection of communicative performance is that it fosters self-monitoring during the process of learning a new skill (Snyder, 2001). Watching oneself giving a scientific presentation on video allows novices to critically observe and assess their own efforts to orally project a science self (i.e. the image of a science expert) and identify self-presentation tactics that can be used to influence the audience's perceptions of their professional image (i.e. impression management strategies). Through reflective practice, students can learn to better regulate how they scientifically present themselves (enact their emerging professional identities), hence developing as science communicators. Our theoretical perspective is presented next.

Theoretical framework

In this study, we adopt an experiential perspective on student development of science communication skills. Aligned with previous scholarship on experiential learning (Dewey, 1938; Kolb, 1984), we believe that students need to be given opportunities to experience oral science communication firsthand to become effective oral communicators of science to a variety of specialized and non-specialized audiences alike. In undergraduate classrooms, this can be effectively accomplished through student participation in communicative tasks or assignments such as giving a scientific presentation. When combined with reflective self-assessment of one's performance, such communicative tasks allow students to develop a clearer and critical awareness of what can be said, how it can be said, and how it can be interpreted by interlocutors. As speakers faced with the challenging task of orally communicating science, students have a chance to practice a skill essential to the science profession and to develop a scientific voice of their own.

Reflective consideration of one's communicative performance requires hindsight access to one's experience as a science communicator. Because reflection occurs outside the experience (i.e. after the presentation), students engage in what is known as *reflection-on-action* (Schön, 1983) – a reflective mode that comes more easily to unexperienced novices (Rodgers, 2002). Students need to be able to systematically look back at their oral presentations to critically assess their emergent communicative skills and reflectively identify possible areas of improvement. In the classroom, this can be done mentally (based solely on students' free recall of their oral presentations) or audio-visually (based on recordings of their oral presentations such as videos) (see Figure 1).

Self-reflection based on free recall taps into *episodic memory* (Tulving, 1972), that is, students' memory of classroom experiences, which can be explicitly stated and intentionally conjured through the process of recollection. While giving oral presentations, episodic information is mentally encoded and stored in the students' long-term memory and can be later retrieved by means of prompted recollection. However, some moments can be more memorable than others depending on a variety of factors such as students' emotional state. Such memorability stems from humans' tendency to attend to and mentally record exceptionally large amounts of detail during emotionally charged and stressful moments, often in the form 'flashbulb memories' (Tulving & Craik, 2000). Moments when students felt a higher degree of emotionality while presenting are encoded more intensely and, as result, stand out in students memory – episodic information can be later retrieved more easily and vividly in comparison to less emotional moments. As such, recall has the potential to become distorted and biased toward more memorable, and often more negative moments. The present study attends to this potential complication by comparatively examining student reflective analysis with and without video.

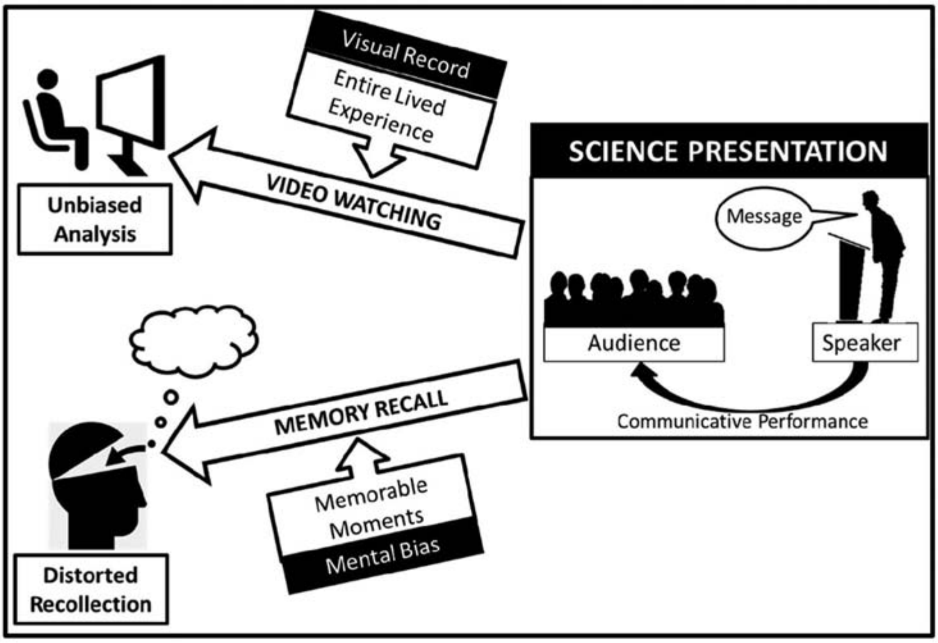

Figure 1. Student reflective analysis of science presentation with and without video aid.

Video reflection is relatively less susceptible to biases related to episodic memorability. As a comprehensive and detailed record of a communicative event or performance that can be repeatedly examined by students, video recordings provide prompt visual access to all moments of an oral presentation (regardless of the speaker's memorability of particular moments). Video recording can make diverse and complex elements of an experience available for slow, moment-by-moment scrutiny. Hence, it is possible for students to reflect back even on those less memorable moments that may have been experienced as unremarkable or not having been noteworthy at first. In other words, video watching can enable students to engage in more objective (less biased) reflective analysis of their initial attempts to give a professional scientific presentation, a lived experience whose recollection is often made difficult ('clouded') by emotionality.

Research design

The present study adopts a mixed-method research approach (Bogdan & Biklen, 2003; Creswell, 2007), relying mainly on descriptive data collected through open-ended research methods such as video recordings and surveys, which were systematically analyzed to build a naturalistic account (Lincoln & Guba, 1985) of undergraduate biology students' classroom experiences with oral science communication in a formal academic context.

Participants and setting

Participants in this study included a group of undergraduate students taking a third-year biology course on the topic of Animal Behavior. Enrollment consisted of a total of 57 students, the majority of which were aged in their early twenties, being Anglo-Canadian with a minority of Franco-Ontarians. The course was taught by the second author (henceforth referred to as Author 2) who held a Ph.D. degree in biology and had approximately 14 years of teaching experience at the university level.

Aimed at introducing students majoring in biology to the scientific study of animal behavior, this 13-week course focused primarily on the ecological and evolutionary benefits (i.e. adaptive value) of a variety of animal behaviors such as communication, altruism and sociality, territoriality, aggression, feeding habits, mating systems and parental care. The course met twice a week for approximately 1.5 h. Another important goal of the course was to develop students' communication skills. More specifically, students were to (1) develop and defend logical, coherent arguments, and (2) be able to disseminate biological information in written and oral format to scientific and non-scientific audiences. To this end, students were also provided with science communication instruction and guidance on how to communicate effectively.

The course also included an oral science communication assignment, in which students had to present a case of animal behavior to their student colleagues in the form of an educational scientific presentation aimed at a non-specialized audience (novice science students). Students were to select a particular animal behavior of personal interest, find two research articles from the primary literature that studied the fitness consequences of that behavior (i.e. the effects on survival and/or reproduction), and then give a presentation on the adaptive value of animal behavior of their choice, adopting the role of a science professor teaching this new material to the students. As part of this assignment, students also had to create a 7-slide PowerPoint slideshow to be used during their presentations.

While presenting, students were to briefly identify the ecological context in which the behavior occurred, the research questions and/or hypotheses, the studies performed and their relevant results, as well as concluding remarks on the relevance of those findings to the field of Animal Behavior. Assessments were partly based on the communication style and coherence (esthetic design, layout, storyline and narrative etc.) and partly on the scientific content (explanation of the context, research presented, interpretation of results etc.).

Data collection

Various methods of data collection were deployed. Firstly, students' oral performances were video-recorded while giving their scientific presentations in class. Secondly, students were asked to complete a written survey immediately after giving their presentations. This survey included questions about their specific experiences giving the presentations (e.g. 'In your opinion, how well did you feel that you did on your presentation immediately after having given it?'), prompting students to choose an answer from the following options: Not well at all / Not very well / Neutral / Pretty well / Very well.

For the purposes of this study, this survey data constitutes the Memory Condition. It captures how students' recalled their science communication experiences immediately after giving their oral presentations. Because this self-assessment was based entirely on free recall (without the benefit of a memory aid like a video), it revealed students self-perceptions as novice science performers trying to project a professional image, personal biases, and assumptions about the nature of scientific communication.

As a third source of data collection, roughly one week later the same students were asked to reflect back on their oral performances and share their feelings after having viewed a video of themselves presenting (e.g. 'In your opinion, how well did you feel that you did on your presentation after having viewed the video recording of it?'). Because video recording was this time used by students as a supplement (a memory aid), this second survey data is referred to as the Video condition in the present study.

Data analysis

Videos of Oral Presentations. The video-recordings were analyzed qualitatively. Discursive records of oral presentations were carefully examined to assess students' communicative performances in light of their own self-assessments. This examination was multi-focal, centering specifically on the three aspects of science communication:

(a) Narration (enthusiasm, concise language, appropriate terminology)
(b) Mastery of subject matter (organization of thought process, logical flow to presentation)
(c) Slideshow esthetics (visually appealing, good balance of text and other media)

Post Presentation Surveys. Student responses in both conditions were transcribed and digitized. Percentage totals of each answer were calculated by dividing by a total of 54 students – 3 out of the 57 did not circle answers under both conditions. Three types of change between conditions were identified: Positive Change, Negative Change, and No Change. The answers were ranked to quantify change: Not well at all = 1, Not very well = 2, Neutral = 3, Pretty well = 4, Very well = 5. Positive change is defined by an answer that scored higher on the answer ranking under the Video Condition than the Memory Condition. Negative Change is defined by an answer that scored lower on the answer ranking under the Video Condition than the Memory Condition. The three broad kinds of change were further considered individually. The percentages of each kind of specific change were calculated again using a total of 54 students.

Students' comments on their presentations in both Memory and Video conditions were assessed for sentiment: positive, negative, or neutral. Definitions of positivity and negativity were inspired and guided by sentiment analysis literature (Liu, 2015). An example student comment from the survey with highlighted *negative* and positive segments of prose is presented here:

> [Memory condition] Though I was very well prepared and did flawlessly when practicing, I was still very *nervous* and after the presentation I felt like everyone would've noticed how *shakey* I was. I'd *hesitated* at one point for a second which seemed like an *endless awkward silence* to me and *I was worried about it*.

> [Video condition] I felt a lot better about it afterwards. I felt like my shakiness hadn't been so apparent after all and that moment of hesitation I mentioned turned out to be hardly noticeable.

Results

Students' oral performances

Students' presentations focused on a variety of biological topics, including camouflage in cephalopods, male parental care among mammals/primates, aggression in birds, mate finding among pandas, snails' inbreeding depression, infant roughing by male baboons, sexual coercion in dolphins, male-male competition in chameleons, salmon foraging strategies, etc.

For the most part, our observations of the videos revealed that students performed consistently well on the science communication task. Our observation notes repeatedly highlighted students' oral strengths while presenting (*appropriate terminology and language use*; *good tone*, *conversational*; *good explanations*; *asking questions and using research to answer was good strategy*; *good use of questions*; *good explanations*).

Students' self-assessment

In agreement with our observations, students mostly thought that they did *Pretty well* on their presentations before and after watching the videos of their presentations (54 and 67%, respectively). In both conditions, few students reported extreme opinions (*Very Well* and *Not well at all*) of their oral performance. Furthermore, the majority of students' ratings (59.26%) were the same before and after watching the videos. Because these students circled the same answers in both the Memory and Video conditions, there was no evidence of video watching engendering any change in self-evaluation. However, for the remaining 40.74%, their circled answers did provide evidence of a change in opinion (both positive and negative). Among these, there were slightly more instances of positive change than negative ones (22.22% and 18.52%, respectively).

Students mentioned a wide variety of topics in their comments, with observable shifts between the Memory and Video conditions. Before watching the video, students tended to focus on aspects of their presentation that pertained to content and information transfer (*what* was being communicated – the message). In the Video condition, there was a stronger focus on physical aspects of student presentations (*how* it was being communicated – the performance). Most notably was a percent increase in mentions of body language, eye contact, and voice (Figure 2). In parallel, there were notable decreases in comments about PowerPoint, engagement, and information transfer. Overall, students' focus shifted from content-heavy aspects of science communication, wherein they saw themselves as disembodied transmitters of information, towards more physical aspects of scientific presentation, in which they began viewing themselves as embodied communicators who engaged with their audience. In other words, attention shifted from the *what* to the *how* of communicating science.

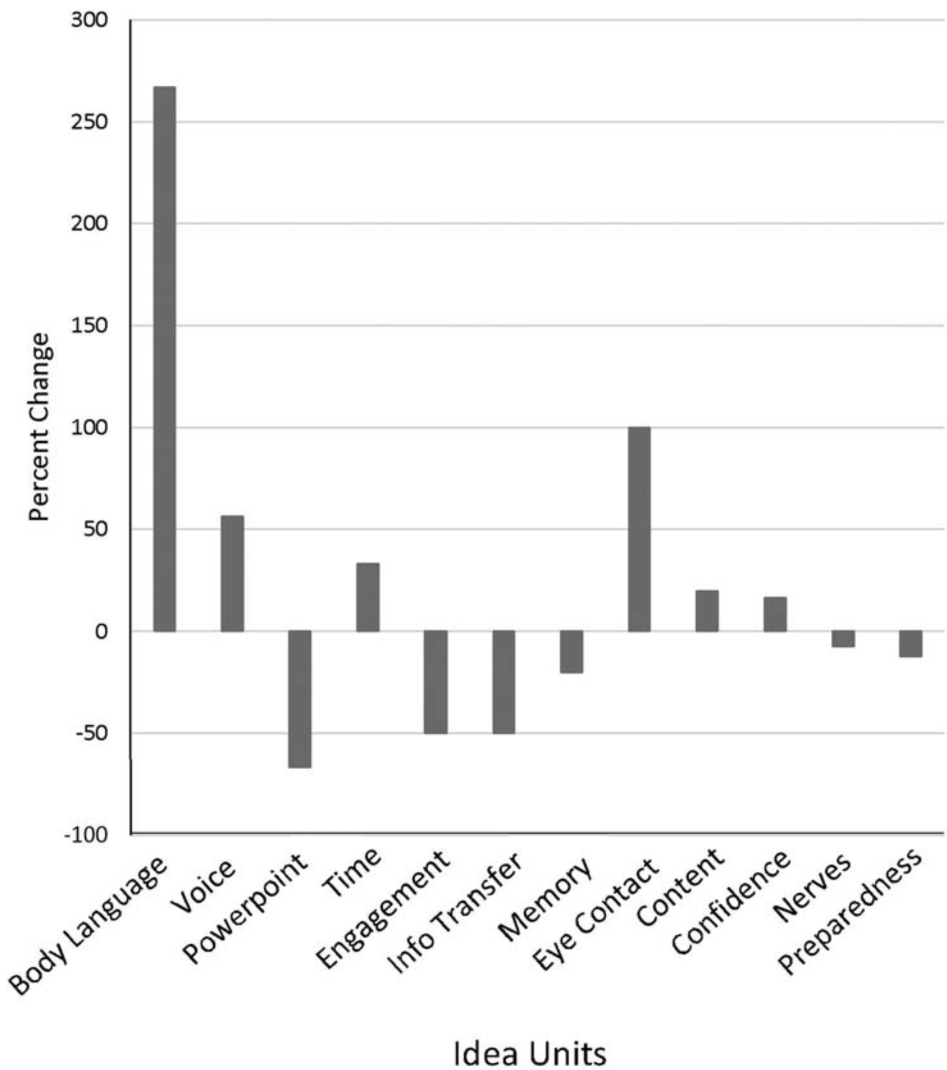

Figure 2. Percent change in frequency of category mentions: from the Memory condition to the Video condition.

The nature of students' evaluation also shifted from the Memory to the Video conditions. Although students also talked little of body language before watching their videos, they mentioned it more frequently and negatively afterwards. Students also mentioned eye contact more negatively after watching their videos. Furthermore, while in the Memory condition, students' comments on transfer of information contained a mix of positivity and negativity, comments in the Video condition were mostly negative.

Discussion

Change in the way students analyzed, assessed, or felt about their presentations occurred for a considerable portion of students through the act of watching a video of themselves (40.74%). For this group of students, video reflection caused change in their overall opinion of, or sentiment towards, the success of their presentation. This indicates that the videos indeed encouraged these students to reflect on their presentations in different ways.

The change in students' self-perceptions was brought about by the objective, outsider perspective that video reflection lent students. In adopting a less personal or emotion-based perspective, students could notice things about their presentations that they had not previously been aware of (Van Es & Sherin, 2002). Video watching provided students with a more detached, third-person perspective that they did not have when they were relying solely on memory.

The reported change in students' self-perception can be construed to signify the power of video to engender professional growth, more specifically, science novices' development as oral communicators (Jacobs & Morita, 2002; Paley, 1986). Such a change is representative of the type of professional growth and development that can result from using video as a tool for self-reflection in undergraduate science, namely the adoption of more developed perspectives on communicative performance. Moreover, the fact that video-watching changed students' self-perceptions in varied ways (made them more positive as well as more negative) underscores the need for more careful analytical consideration.

As described above, there were slightly more instances of positive change than negative ones (22.22% and 18.52%, respectively). Overall, sentiment shifted positively for many students who felt badly about their presentations to begin with. Positive change was most prevalent for those students who felt not well at all about their presentations, signifying that the most self-critical students' opinions were likely soothed by the objective perspective the videos offered them. On the other hand, those that felt very well about their presentations displayed the most negative change. Such findings suggest that students with the most extreme opinions may be the ones for whom video reflection may show the most benefit. Video reflection seemed to enable these students to develop more balanced self-perceptions that were less emotionally biased by any perceived weaknesses or perceived strengths in their communicative performance. Video reflection had an overall mitigating effect on the students' self-perceptions, suggesting that it may be most useful to those at the fringes of opinion about their emergent professional images.

Psychological research on social anxiety can help shed some light on the significance of the reported positive changes in students' sentiments about their self-presentation. Evidence exists that negative self-perception can be traced to a *perfectionistic self-presentation style* (Flett & Hewitt, 2014), a type a person who publicly tries to project a perfect image while also defensively covering up mistakes. Because they perceive themselves to be subjected to unrealistic standards/expectations, these people tend to be too focused on the need to be perfect and are excessively concerned with mistakes (discrepancies) that may prevent them from achieving the desired perfection. Such unrealistic expectations often lead to negative self-perception, a degree of social anxiety, and less effective performance (similar to a 'self-fulfilling prophecy'). From this psychological perspective, it can be argued that the reported positive changes in students' sentiments about their oral presentations after watching the video are indicative of a reduced degree of perfectionistic self-presentation style among the biology students. Students tended to become less concerned about any small imperfections in their communicative performances, and hence less critical of themselves. Developing this less negative perception on the self is an important step in overcoming any social anxiety that novice scientists may experience while giving their first scientific presentations, and hence gradually improving their oral performances.

Likewise, the occurrence of negative change in students' sentiment is also indicative of professional growth as it represents development of objective criticism toward one's own performance (Van Es & Sherin, 2008). By allowing students to adjust (fine tune) their positive opinions and impressions, video reflection provided them an opportunity to learn and grow in specific performative areas and target particular presenting skills. Therefore, it stands to reason that, like negative changes, positive changes in students' self-perceptions also constituted professional growth. Both seemed to lead to a more balanced perception of how effectively students presented their selves while giving a scientific oral presentation.

Another notable area of change in student responses was a shift from content-based observations to more performance-based ones. After watching their presentations, students focused less on information transfer (the what) and more on performative aspects of presenting like body language, voice, and eye contact (the how; Figure 2). This shift reflects the recent trends in science communication theory: away from old theories of science communication as a disembodied process of message transmission (akin to broadcasting a signal to TV receiver), towards more recent theories of science communication as an interactive dialogue between speaker and audience (Rédey, 2006). Rather than mechanical transmitters, students began positioning themselves as human beings socially interacting with other humans. Watching their presentations caused students to more actively consider their embodied social roles when presenting information, as opposed to solely focusing on the information itself. Such a shift is essential if undergraduate science students are to recognize that, as scientists, they are also inherently science communicators with a responsibility for the way in which they engage with their audiences, rather than professionals concerned solely with the quality and content of information.

Conclusion

This study revealed that video-based self-reflection had merit as a tool for promoting student development as oral science communicators in the context of the examined undergraduate biology class. However, it should be noted that the reported results are not broadly applicable given the small sample size and single classroom context. Moreover, data collection was limited to one single presentation. Whether video self-reflection may result in an improvement in students' subsequent scientific presentations remains to be examined by future studies. Nonetheless, despite these limitations, it was clearly demonstrated that reflectively watching themselves on video helped many students in the examined biology class see aspects of their oral presentations differently than before and learn from the experience of giving a scientific experience. Whether video watching helped participating students refute extreme opinions, bring up new notions, supplement critique, or see from a less emotional viewpoint, change in self-perception invariably led to a degree of professional growth. As such, initial evidence is provided that video reflection can indeed help in the training of novice scientists as professionals with more developed oral communication skills. It is our hope that the reported findings can help science educators to more effectively capitalize on the power of video-based self-reflection to provide undergraduate students with transformative experiences during their oral science communications.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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